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ABSTRACT

This teacher's guide is part of an instructional series on small engine repair that is intended for use with mentally retarded and learning disabled students in general mechanical repair programs. Notes to the instructor cover equipment needed, preparation before teaching, and use of evaluation charts, transparency masters, audiovisual(s), and student activities. Other contents include a list of prerequisite skills, a chart of student goals and objectives, activities and materials to achieve them, a list of vocabulary terms, 13 transparency masters, narrative for an audiovisual presentation, six student activity sheets, answers to the activity sheets, an evaluation model, and a reference list. (This material has been developed as an extension of Comprehensive Small Engine Repair--ED 146 392--published by the Mid-American Vocational Curriculum Consortium, Inc. It is recommended that the two be used together.) (YLB)

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SMALL ENGINE REPAIR SERIES

TX8313304

ED240378

TROUBLESHOOTING

Teacher's Guide
and
Student Activity Sheets

Prepared by Pamela Hill

CE038335

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TEACHER'S GUIDE FOR TROUBLESHOOTING

TABLE OF CONTENTS

	PAGE
PREFACE	v
ACKNOWLEDGMENTS	vii
NOTES TO THE INSTRUCTOR	1
STUDENT PREREQUISITE SKILLS	5
STUDENT GOAL AND OBJECTIVES	7
VOCABULARY TERMS FOR TROUBLESHOOTING	9
TRANSPARENCY MASTERS	11
TM 1: Carburetion	
TM 2: Compression	
TM 3: Ignition	
TM 4: Common Signs of Engine Failure	
TMs 5-12: Seven Troubleshooting Steps	
TM 13: Troubleshooting Chart	
NARRATIVE FOR AUDIOVISUAL PRESENTATION: Troubleshoot a Small Gasoline Engine	37
STUDENT ACTIVITY SHEETS	47
ANSWERS TO STUDENT ACTIVITY SHEETS	59
EVALUATION MODEL	63
REFERENCES	67

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PREFACE

TROUBLESHOOTING, an instructional package in the Small Engine Repair Series, was developed, field-reviewed, and evaluated by vocational industrial teachers who teach students about repairing small engines. This material was developed as an extension of Comprehensive Small Engine Repair by the Mid-America Vocational Curriculum Consortium, Inc., and we recommend the two be used together.

This project, now in its third year, was initiated in 1979 because it was felt that special needs students enrolled in General Mechanical Repair programs in Texas needed more appropriate instructional materials to aid their learning. The aim of this project has been twofold: (1) To task analyze the typical repair jobs of small engines and then identify the minimum required information, safety, and work habits associated with each repair job; and (2) To present this material in a variety of ways that are consistent with learning styles of special needs students with cognitive dysfunctions--primarily, the mentally retarded and learning disabled.

TROUBLESHOOTING is designed with a combination of different media approaches--audio, visual, and hands-on. It is anticipated that this balanced multimedia approach will not only provide an opportunity for students to experience learning from different angles, but will also make learning more interesting and easier. Included in TROUBLESHOOTING are the following instructional materials:

Audiovisual: Troubleshoot a Small Gasoline Engine
Teacher's Guide: with accompanying student activities

Audiovisual

The audiovisual presentation discusses a systematic way to troubleshoot an engine while analyzing some of the more common reasons for engine failure. The presentation is available in either filmstrip/cassette or slide/cassette style. It is short and concise, with simplified language to hold the interest of the special needs learner. The Fogg Index reading level of the audiovisual script is approximately grade 6.6 minus the technical words such as carburetion, compression, troubleshooting, etc.

Designed to be used in both group and individual instruction, the audiovisual presentation may be used before or after discussion and/or demonstration of troubleshooting. If repetition is needed in order for a student to complete the Student Activity Sheets, the presentation may also be viewed individually without teacher assistance. For the student who is an auditory learner or blind, listening to the cassette will be an important aid in that student's ability to learn about troubleshooting.

Teacher's Guide

The Teacher's Guide will help provide successful learning experiences for the special needs student. Performance objectives are given for inclusion in a student's Individual Instructional Plan (IIP). Transparency Masters, the script for the audiovisual, Student Activity Sheets, and an evaluation chart are provided to support a variety of teaching methods and individualization of instruction.

For further information or to comment on TROUBLESHOOTING or any of the presentations in the Small Engine Repair Series, contact the Occupational Curriculum Laboratory, Mayo Hall, East Texas State University, Commerce, Texas 75428, or phone (214) 886-5623.

NOTES TO THE INSTRUCTOR

Introduction

TROUBLESHOOTING is an audiovisual aid developed to introduce this concept and help the student learn a systematic way to troubleshoot while learning about some of the more common reasons for engine failure.

This instructional package consists of 63 full-color slides or a 35mm filmstrip, a cassette tape and a teacher's guide. The Teacher's Guide contains information on how to use this instructional package, the script for the audiovisual presentation, transparency masters, student activities, and a student evaluation chart. These materials may be used as either primary or supplementary instructional materials for the topic of troubleshooting. The printed materials provided in the Teacher's Guide are not copyrighted and so they may be reproduced in any form for student use. There are no separately printed student materials for TROUBLESHOOTING.

EQUIPMENT NEEDED

Before using this presentation, arrange to have the following equipment available:

- Projector (either carousel slide or filmstrip type)
- Carousel tray, if using slides
- Projector screen
- Cassette recorder
- Overhead projector and other equipment necessary for making transparencies
- Tools and 4-stroke-cycle gas engines

Preparation Before Teaching This Instructional Package

Before you begin teaching this instructional package, there are some things you should do. These will help ensure successful learning of TROUBLESHOOTING by each student.

1. Preview all instructional materials provided in the Teacher's Guide, and view the audiovisual presentation.

2. Determine when and how these materials will be used in your class.

3. Assess each student for the Student Prerequisite Skills before introducing the instructional package. These prerequisite skills are provided in this guide.

4. Gather additional resources necessary to teach the prerequisite skills to those students who are deficient.

STUDENT GOAL AND OBJECTIVES

The student goal and objectives for this instructional package follow the Notes to the Instructor. Included with each objective are several suggestions for student activities, several of which are provided in this guide. These are to assist you in writing each student's Individual Instructional Plan (IIP).

1. Discuss the goal and objectives with each student so that it is clearly understood what is expected of the student.

2. Add any additional objectives such as prerequisite skills which need to be learned by the student.

TRANSPARENCY MASTERS

Numerous 8½" x 10" illustrations have been provided in the Teacher's Guide to be used in a variety of ways:

1. As transparencies. If so, make an acetate of each illustration so that it may be projected onto a screen, using an overhead projector.

2. Copied and used as hand-outs to students.

3. As materials to be used in Student Activities.

4. As display material for a bulletin board.

PROCEDURES FOR SHOWING THE AUDIOVISUAL PRESENTATION

1. Plan a short, but relevant introduction to tell students what to look for in the presentation. Use the transparencies to help explain information.

2. Allow enough time to show the presentation and for student discussion.

3. Show the audiovisual presentation to the students in a group or individual setting.

   NOTE: Due to the long length of this presentation, it is advised that it be shown in segments and that students be given the corresponding student activity sheet to complete before going on with the presentation. The presentation could be broken into the following sections:

Slides 1-18:	What does troubleshooting mean?
Slides 15-24:	The first five steps of troubleshooting
Slides 25-55:	Inspecting an engine when troubleshooting
Slides 56-63:	The last two steps of troubleshooting

4. Ask students to highlight the major points of the presentation, using the Student Activity Sheets provided in this guide. Show the presentation a second time if necessary.

5. Stress the importance of safety while troubleshooting engines.

STUDENT ACTIVITIES

Student Activity Sheets are provided to help reinforce the information presented on the audiovisual. Directions for administering Student Activity Sheets 1-5 are flexible in that they may serve as an outline for a group discussion or students may answer the questions individually and in writing. Student Activity Sheet 6 may serve as a checklist to be used several times when troubleshooting engines.

EVALUATION MODEL

It is encouraged that a grading system not be based on the written activities provided for the student, but rather on individual physical performance of troubleshooting an engine. An evaluation chart is provided in this Teacher's Guide for this purpose. The chart is intended for use as a grading instrument and as a motivational aid by rating personal progress toward troubleshooting a small engine.

1. Discuss with the students how they will be evaluated, based on individual performance shown by the evaluation chart.

2. See the section titled "Evaluation Chart" for specific instructions on how to use the evaluation chart.

STUDENT PREREQUISITE SKILLS

Listed below are prerequisite skills which the student needs in order to successfully learn how to troubleshoot a small gasoline engine. It is recommended that the instructor not introduce this unit until the student has learned most of the repair jobs associated with the various systems of a small engine.

PREREQUISITE SKILLS	SUGGESTED ACTIVITIES
1. Demonstrates a working knowledge of safety with small gasoline engines.	Refer to SAFETY of the Small Engine Repair Series.
2. Demonstrates knowledge and repair skills associated with the magneto-ignition system; e.g., service a fouled spark plug, remove and replace contact points and condenser, and check flywheel magnet and set armature air gap.	Refer to MAGNETO SYSTEM of the Small Engine Repair Series.
3. Demonstrated knowledge and repair skills associated with the lubrication system; e.g., check and change the engine oil and service the crankcase breather.	Refer to LUBRICATION SYSTEM of the Small Engine Repair Series.
4. Demonstrated knowledge and skills associated with engine identification; e.g., start, adjust, and stop the engine and check the oil and fuel levels.	Refer to ENGINE IDENTIFICATION of the Small Engine Repair Series.
5. Demonstrates knowledge and repair skills associated with the starting system; e.g., replace the rewind rope and rewind spring.	Refer to STARTING SYSTEM of the Small Engine Repair Series.
6. Demonstrates knowledge and repair skills associated with the fuel system; e.g., service the carburetor air cleaner, service the carburetor diaphragm, and service a 2-piece flo-jet carburetor.	Refer to FUEL SYSTEM of the Small Engine Repair Series.
7. Demonstrates knowledge and repair skills associated with the cooling system; e.g., service air cooling parts.	Refer to COOLING SYSTEM of the Small Engine Repair Series.
8. Demonstrates knowledge and repair skills associated with the governor system; e.g., service the air vane governor.	Refer to GOVERNOR SYSTEM of the Small Engine Repair Series.

9.	Demonstrates knowledge and repair skills associated with the exhaust system; e.g., service 4-stroke cycle exhaust system parts.	Refer to EXHAUST SYSTEM of the Small Engine Repair Series.
10.	Demonstrates knowledge and repair skills associated with engine overhaul; e.g., use a plain micrometer, dissasemble and service a 4-stroke cycle engine, service a multi-piece crank-shaft, and reassemble a 4-stroke cycle engine.	Refer to ENGINE OVERHAUL of the Small Engine Repair Series.

STUDENT GOAL AND OBJECTIVES

The following are provided to assist in the development and writing of each student's Individual Instructional Plan (IIP). Built into these objectives is the use of the evaluation chart found in this Teacher's Guide. You will want to use these charts for monitoring each student's progress toward these objectives. Criterion for competency or the rating that a student must achieve for a pre-determined length of time is suggested as a rating of 3 for three consecutive days on the evaluation chart. See "Evaluation Model," page 65, for further information.

LONG-TERM GOAL: After completing TROUBLESHOOTING the student will be able to identify information about troubleshooting and follow the seven troubleshooting steps when diagnosing engine trouble.

SHORT-TERM OBJECTIVES	ACTIVITIES AND MATERIALS
1. Given information about troubleshooting a small gasoline engine, the student will identify and explain the following information for three consecutive days: * What troubleshooting means. * Three things needed to make an engine run. * Common signs of engine failure. * Seven troubleshooting steps.	1. Using transparencies 1-13, participate in class discussion on troubleshooting and the 7 troubleshooting steps. 2. Watch the audiovisual presentation, "Troubleshoot a Small Gasoline Engine." 3. Using the audiovisual presentation, answer the questions on Student Activity Sheets 1 through 5. 4. Using the Troubleshooting Evaluation Chart, rate the students' progress for two consecutive weeks, or until a rating of 3 is achieved for three consecutive days.
2. Given a small gas engine, tools, and a troubleshooting chart, the student will accurately troubleshoot the engine by correctly following the seven steps without help for three consecutive days.	1. Observe as the teacher goes through the steps in troubleshooting an engine. 2. Using Student Activity Sheet 6 and the Troubleshooting Chart, practice troubleshooting an engine.

3. Repeat Activities 1 and 2 for two weeks, or until a rating of 3 on the Trouble-shooting Evaluation Chart is achieved for three consecutive days.

NOTE TO THE TEACHER: Repeat the above activities for a minimum of six times, each time using an engine with a different problem--which you have staged--to be diagnosed. Some examples of engines with problems are: sheared flywheel key, water in the fuel tank, fouled spark plug with incorrect gap, incorrect timing, clogged muffler or cooling fins, and worn rings.

VOCABULARY TERMS FOR TROUBLESHOOTING

1. Carburetion--the mixing of fuel and air into a fine mist so that it will burn.

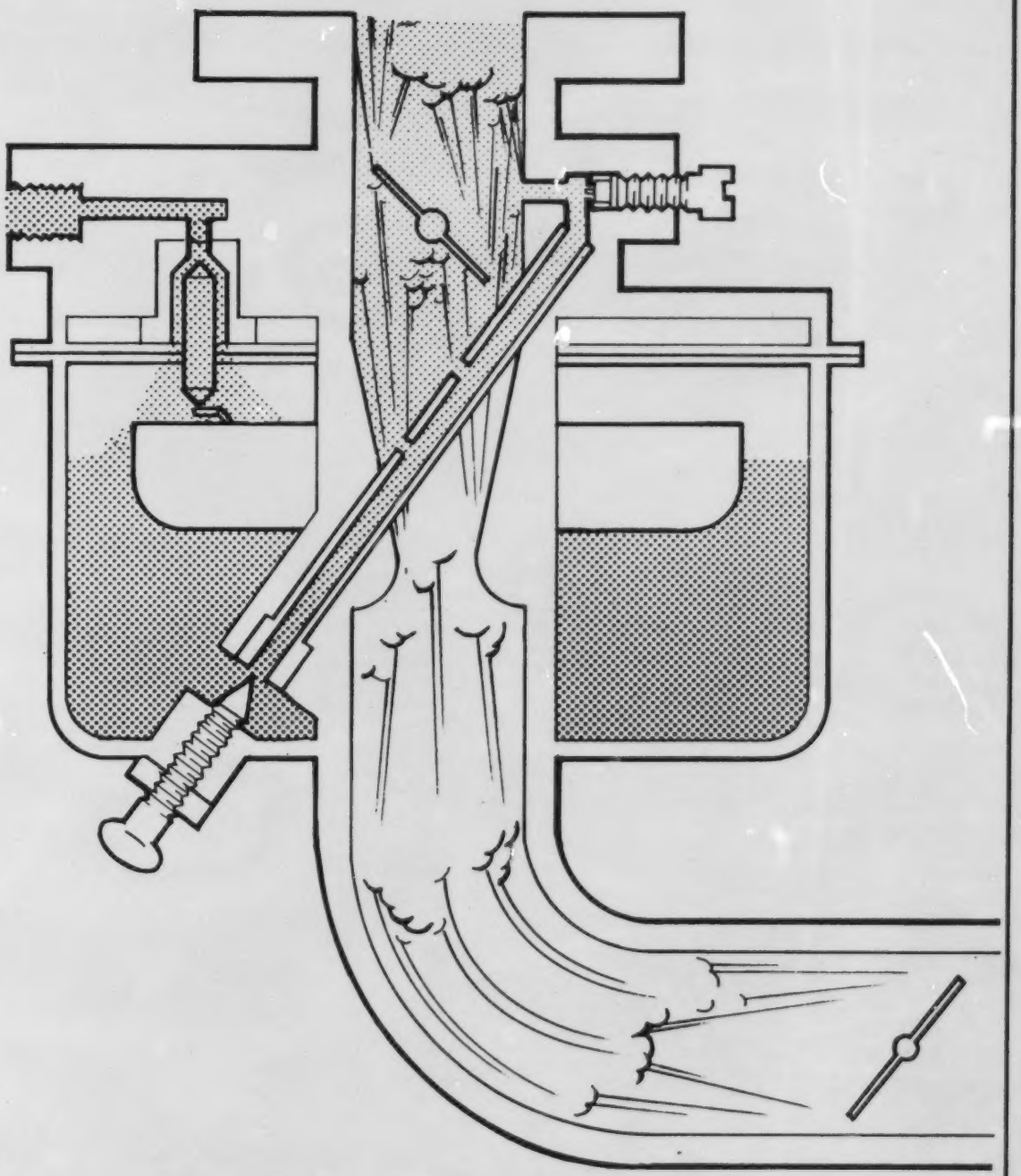
2. Compression--squeezing the fuel and air mixture into a small space in the combustion chamber so that when the mixture is ignited it will create power.

3. Ignition--the action of setting fire to the compressed air/fuel mixture which causes an explosion in the combustion chamber.

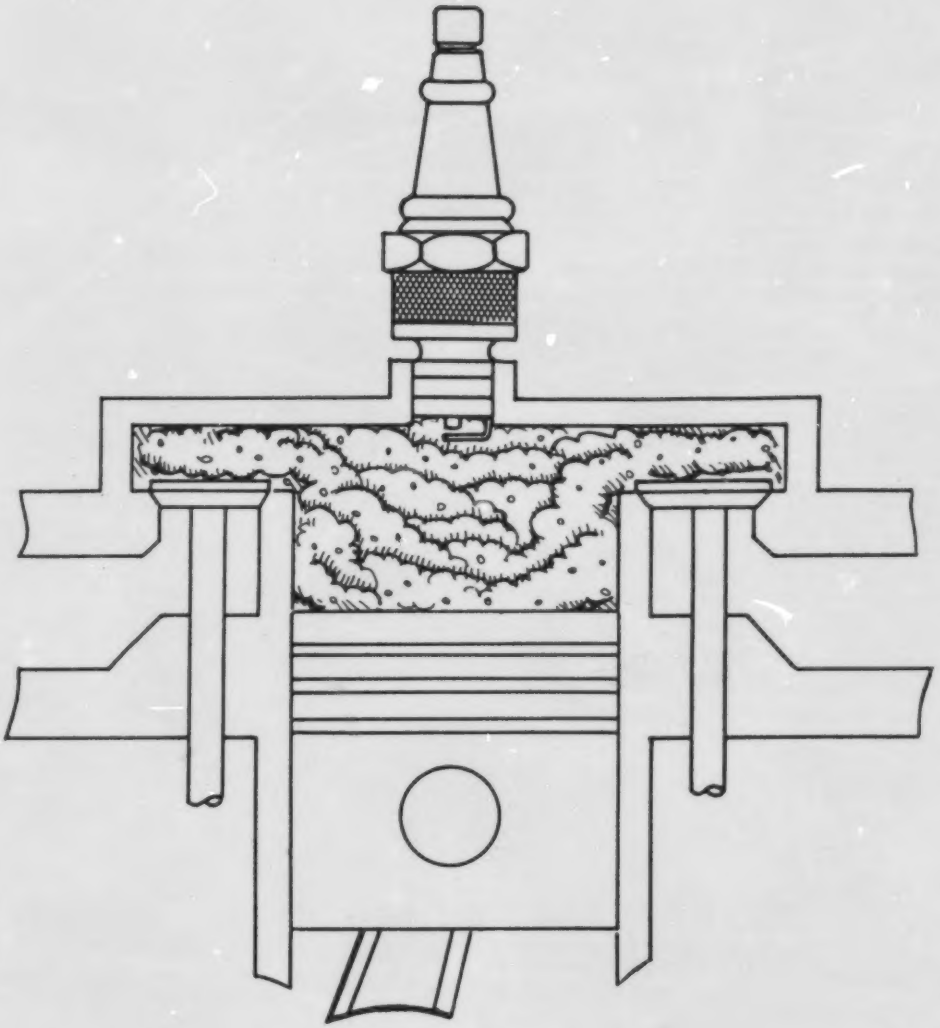
4. Parts exchanging--putting new parts into an engine before the engine trouble has been diagnosed.

5. Troubleshooting--using a step-by-step process to find the cause of engine failure.

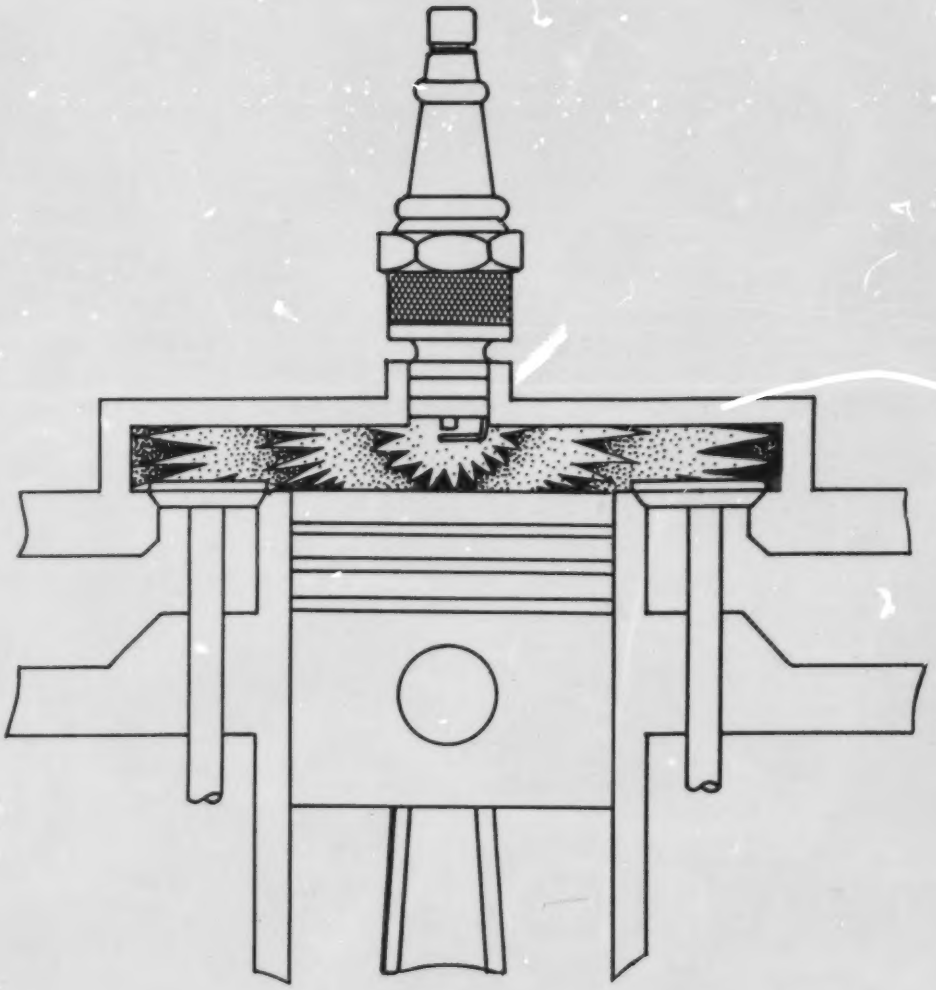
CARBURETION



COMPRESSION



IGNITION



Common Signs of Engine Failure

- ★ Will not Start
- ★ Knocks
- ★ Misfires
- ★ Lacks Power
- ★ Overheats
- ★ Surges or Runs Unevenly
- ★ Shakes

7 Troubleshooting Steps

1. Know the Engine

2. Find Out the Signs

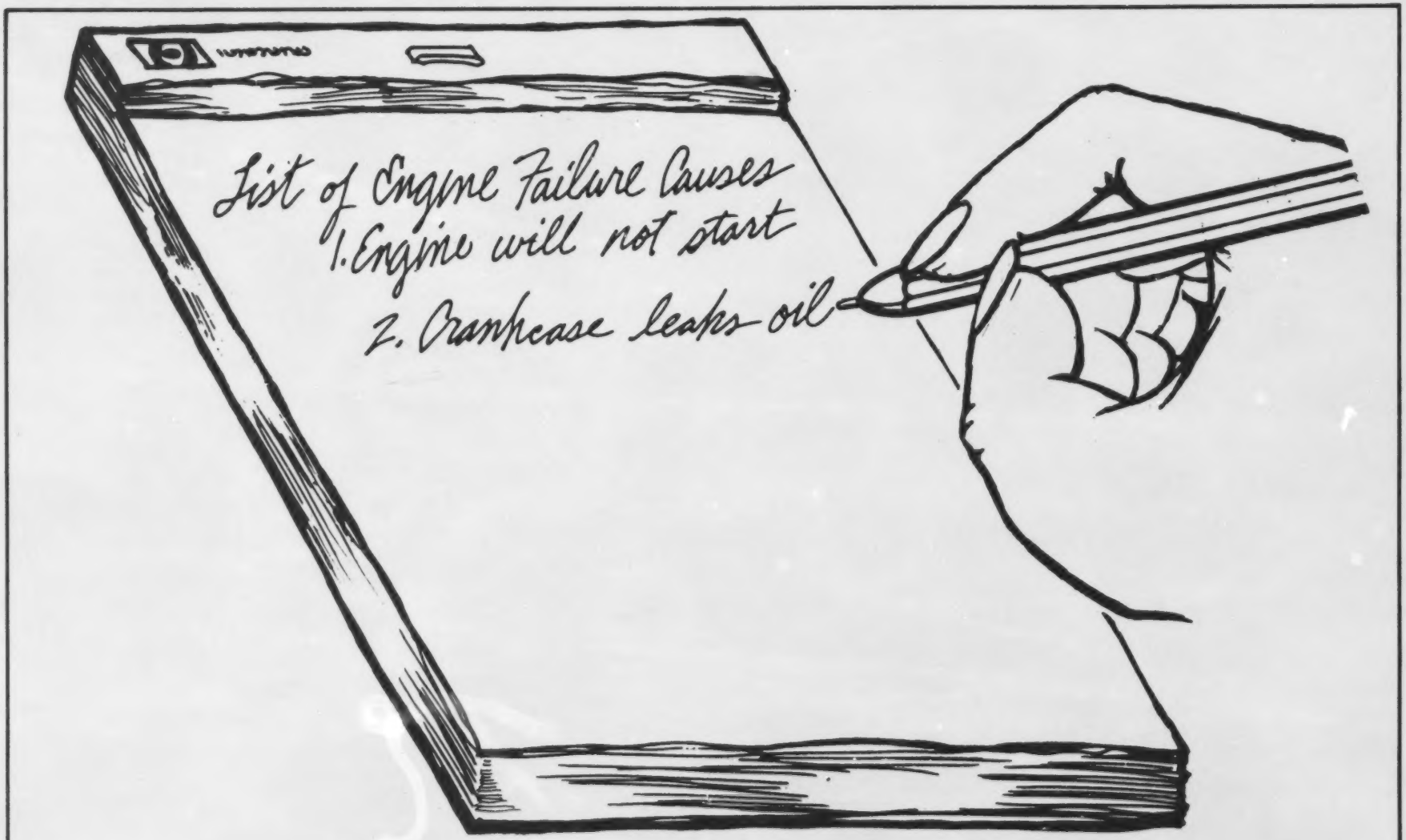
TM-6

21

3. Start the Engine

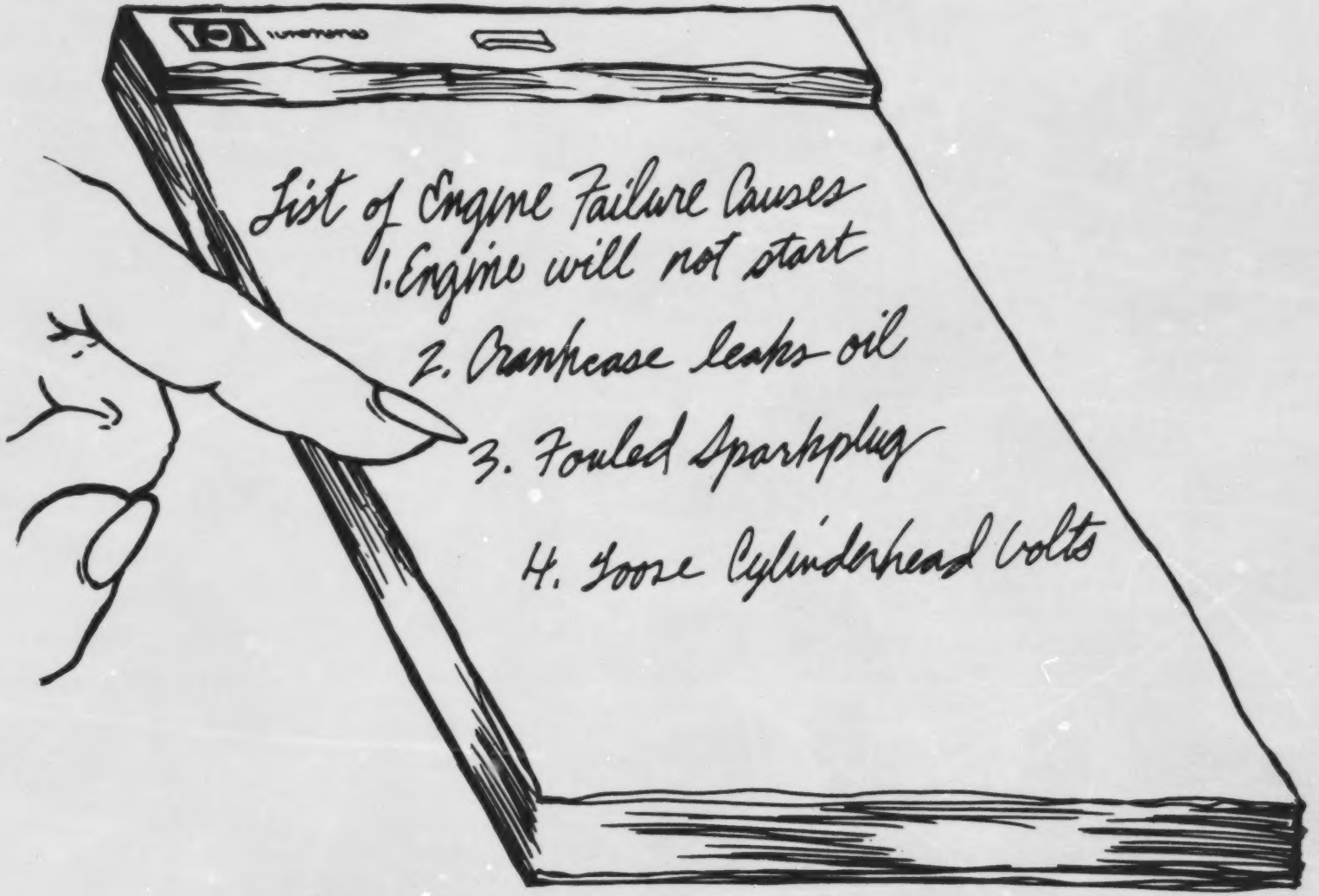
TM-7

4. Inspect the Engine



5. List Possible Causes

TM-9


List of Engine Failure Causes
1. Engine will not start
2. Crankcase leaks oil
3. Fouled Sparkplug
4. Loose Cylinderhead Bolts

6. Make a Conclusion

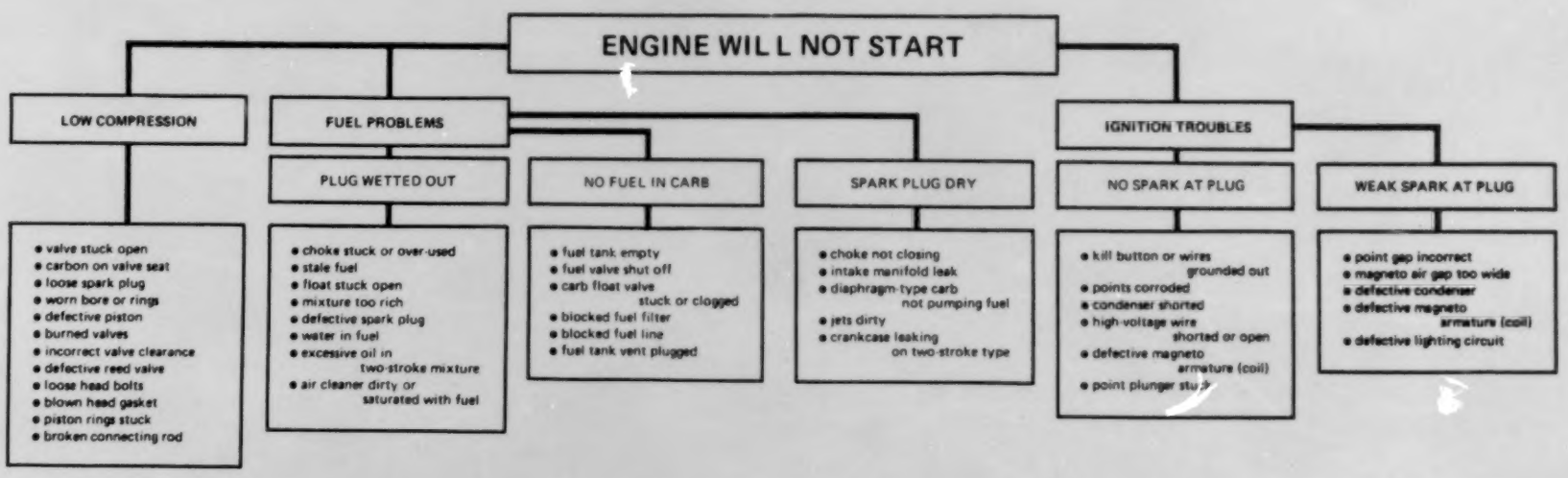
7. Test the Conclusion

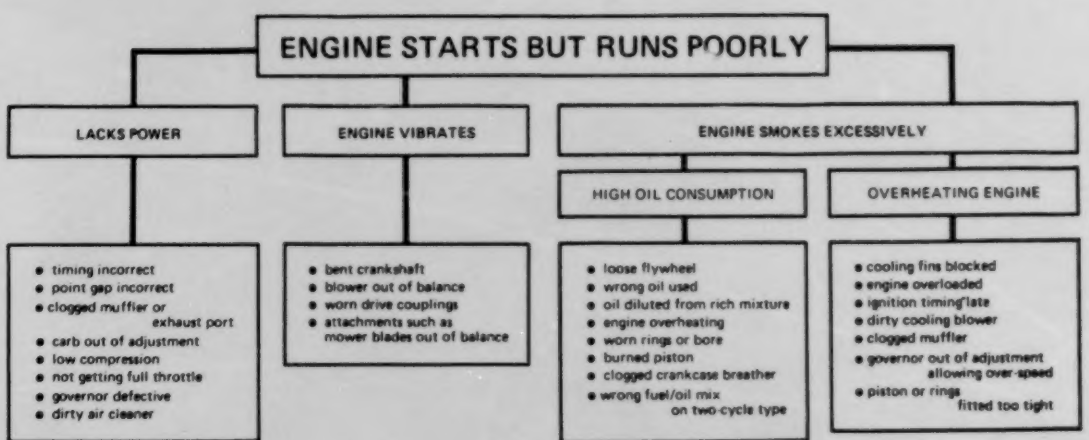
7 Troubleshooting Steps

1. Know the Engine
2. Find Out the Signs
3. Start the Engine
4. Inspect the Engine
5. List Possible Causes
6. Make a Conclusion
7. Test the Conclusion

TM-12

SMALL ENGINE TROUBLESHOOTING CHART


ENGINE WILL NOT START
LOW COMPRESSION
• valve stuck open
• carbon on valve seat
• loose spark plug
• worn bore or rings
• defective piston
• burned valves
• incorrect valve clearance
• defective reed valve
• loose head bolts
• blown head gasket
• piston rings stuck
• broken connecting rod
FUEL PROBLEMS
PLUG WETTED OUT
• choke stuck or over-used
• stale fuel
• float stuck open
• mixture too rich
• defective spark plug
• water in fuel
• excessive oil in two-stroke mixture
• air cleaner dirty or saturated with fuel
NO FUEL IN CARB
• fuel tank empty
• fuel valve shut off
• carb float valve stuck or clogged
• blocked fuel filter
• blocked fuel line
• fuel tank vent plugged
SPARK PLUG DRY
• choke not closing
• intake manifold leak
• diaphragm-type carb not pumping fuel
• jets dirty
• crankcase leaking on two-stroke type
IGNITION TROUBLES
NO SPARK AT PLUG
• kill button or wires grounded out
• points corroded
• condenser shorted
• high-voltage wire shorted or open
• defective magneto armature (coil)
• point plunger stuck
WEAK SPARK AT PLUG
• point gap incorrect
• magneto air gap too wide
• defective condenser
• defective magneto armature (coil)
• defective lighting circuit


ENGINE STARTS BUT RUNS POORLY
LACKS POWER
• timing incorrect
• point gap incorrect
• clogged muffler or exhaust port
• carb out of adjustment
• low compression
• not getting full throttle
• governor defective
• dirty air cleaner
ENGINE VIBRATES
• bent crankshaft
• blower out of balance
• worn drive couplings
• attachments such as mower blades out of balance
ENGINE SMOKES EXCESSIVELY
HIGH OIL CONSUMPTION
• loose flywheel
• wrong oil used
• oil diluted from rich mixture
• engine overheating
• worn rings or bore
• burned piston
• clogged crankcase breather
• wrong fuel/oil mix on two-cycle type
OVERHEATING ENGINE
• cooling fins blocked
• engine overloaded
• ignition timing late
• dirty cooling blower
• clogged muffler
• governor out of adjustment allowing over-speed
• piston or rings fitted too tight

TROUBLESHOOTING: Troubleshoot a Small Gasoline Engine

SLIDE NO.	SLIDE DESCRIPTION	NARRATIVE
1	(Start sound)	(Music up)
2	TROUBLESHOOTING: Troubleshoot a Small Gasoline Engine	(Music under) Troubleshoot a Small Gasoline Engine (Music out)
3	Customer who is talking to small engine mechanic in a repair shop about her broken lawnmower	When a small gasoline engine is brought into a repair shop, most likely the customer will not know the cause of engine failure and it will be up to the machanic to find the problem and then correct it.
4	Mechanic working on engine	So, one of the most valuable skills you can have as a mechanic is to be able to quickly and accurately find the cause of the engine failure.
5	"Troubleshooting is a step-by-step process of finding the cause of engine failure."	Being able to find the cause or trouble of engine failure is a step-by-step process called troubleshooting.
6	Troubleshooting 1. Why follow a trouble-shooting procedure 2. 7 troubleshooting steps 3. Common causes of engine failure	In this presentation, you will learn why you should follow a troubleshooting procedure, the seven basic troubleshooting steps, and about some of the more common causes of engine failure.
7	Mechanic bent over lawnmower. Mechanic is thinking "fouled plug?" "no fuel?" "poor timing?" "sheared flywheel key?"	Learning to quickly and accurately troubleshoot an engine takes a lot of practice and therefore, it is important that you understand all the "how and whys" of engine operation.
8	Fuel and air mixing in carburetor Carburetion Piston in compression stroke Compression Spark at spark plug electrodes Ignition	So, let's first review the three things that must happen in an engine to make it run. These are: carburetion, compression, and ignition.

SLIDE NO.	SLIDE DESCRIPTION	NARRATIVE
9	Air-fuel mixing in carburetor	Carburetion is the mixing of air and fuel into a fine mist so that it will burn.
10	Air-fuel mixture being compressed into combustion chamber by piston	Compression is when the air-fuel mixture is squeezed into a small space in the combustion chamber so that when it is ignited, the mixture will create power.
11	Spark plug firing and igniting air-fuel mixture in combustion chamber	Ignition is the action of setting fire to the compressed air-fuel mixture and causing an explosion in the combustion chamber.
12	Air-fuel mixing in carburetor | Piston in compression stroke | Spark at spark plug electrodes	Troubleshooting is making sure that all three of these things--carburetion, compression, and ignition--are happening in the engine at the right time.
13	7 Troubleshooting Steps 1. Know the engine 2. Find out the signs 3. Start the engine 4. Inspect the engine 5. List possible causes 6. Make a conclusion 7. Test the conclusion	Before repairing an engine, a good mechanic will follow these seven steps to troubleshooting. Following these troubleshooting steps will insure a better repair job and operating dependability because all the engine systems will be checked, thus giving the mechanic more opportunity to find weak or failing parts that could cause engine failure in the future.
14	"Parts Exchanging" Mechanic bent over lawnmower. New parts nearby	Another reason for following a troubleshooting procedure is to avoid the problem of parts exchanging. This happens when a mechanic puts new parts in an engine, hoping to correct the failure before really understanding the problem. This practice is often very expensive for the customer.
15	1. Know the Engine	Now, let's discuss the 7 troubleshooting steps. The first step is to know the engine; be familiar with how the engine is designed and how it operates.
16	Mechanic reading a service manual	A good mechanic has studied the service manuals of the most popular types and models of small engines, like the Briggs and Stratton and Tecumseh engines, and keeps up with the latest service bulletins that are sent out by these companies.
17	2. Find out the signs	The second step in following a troubleshooting procedure is to find out about the engine's performance.

SLIDE NO.	SLIDE DESCRIPTION	NARRATIVE
18	Common Signs of Engine Failure Will not start Knocks Misfires Lacks power Overheats Surges or runs unevenly Shakes	Keep in mind some of the most common signs of engine failure. These are: the engine will not start, the engine knocks, the engine misfires, the engine does not have enough power, the engine overheats, the engine surges or runs unevenly, or the engine shakes.
19	Mechanic talking to customer	When finding out the signs, ask the customer several questions. Ask, "What is happening in the engine that is not supposed to happen; for example, does the engine knock, misfire, overheat, or vibrate?"
20	Mechanic talking to customer	Also ask the customer what is not happening in the engine that is supposed to happen; for example, does the engine start and does it run evenly? And how is the engine used, how often is it used, and how frequently is it cleaned and serviced?
21	3. Start the engine 4. Inspect the engine	The third and fourth steps in following a troubleshooting procedure are, if possible start the engine and inspect it while it is running, if you have been able to start it.
22	Mechanic inspecting floor under lawnmower for oil leaks	Listen to the sounds that the engine makes, look for oil leaks, and any other unusual behavior. Remember not to begin repairing any worn out or broken parts until you have inspected all the engine systems and know about all the things that might be wrong with the engine. We will talk more about this step in just a moment.
23	Mechanic writing down list of possible causes in note pad	Now, while you are inspecting the engine, list all the possible causes of engine trouble that you find.
24	5. List possible causes	Listing all the possible causes of engine trouble is the fifth step in troubleshooting.
25	Oil dipstick near oil-fill hole	Now, let's back up and talk some more about how to inspect the engine. The first things to check for will be: 1. low fuel and oil levels or dirty oil, . . .
26	Fuel strainer being checked	2. a faulty fuel system, . . .

SLIDE NO.	SLIDE DESCRIPTION	NARRATIVE
27	Fiber disc valve on breather being measured with wire feeler gauge	3. restrictions in the air intake passages, like a clogged breather, and. . .
28	Spark plug wire being checked	4. connections of all the hoses, manifold, and wires to be sure each is secure and tight.
29	Arrow pointing to fuel tank with cap off	If the engine will not start or run properly, most likely the cause will be in the fuel system. When inspecting for a faulty fuel system, first check to see that the fuel tank is at least half full.
30	Arrow pointing to fuel shut-off valve	Some engines have a fuel shut-off valve, so make sure it is open.
31	Water and gas in sediment bowl	Sometimes water collects in a fuel tank causing the engine not to run. If you think there is water in the fuel tank, then the fuel tank and lines will need to be drained and cleaned.
32	Arrow pointing to pinched fuel line	Some engines have fuel filters or fuel lines going from the fuel tank to the carburetor, and these can become clogged or pinched. Check to see that fuel will flow through the line.
33	Wire being pushed through the vent holes on cap	Next, check to see if the air intake for the fuel system is clear. Very often, the holes on the fuel tank cap will become clogged and not allow gasoline to be sucked from the tank. Clean the vent holes with a small wire.
34	Arrow pointing to cooling fins around cylinder	Check the engine cooling fins. These fins often become clogged with dirt and grass and will not allow air to flow around the engine. This clogging could easily cause the engine to overheat.
35	Hand holding air cleaner cover off of dirty filter	Check the air cleaner to make sure the filter is clean. If the filter is clogged, the engine will overchoke and cause flooding.
36	Arrow pointing to choke valve in carburetor	While you have the air cleaner off of the carburetor, also check the choke valve to make sure it is not stuck, and . . .

SLIDE NO.	SLIDE DESCRIPTION	NARRATIVE
48	Hand pouring tablespoon of oil into spark plug hole	If a low compression reading is not caused by any of these, then it could be caused by something inside the engine. Check for dry piston rings and cylinder walls by pouring a tablespoon of oil into the spark plug hole.
49	Compression gauge connected to engine showing good compression	If the compression rises, then the trouble may be bad rings, or if the engine had been allowed to sit for a long time, the rings just needed reoiling. If the compression does not rise, the trouble could be a stuck or bad valve, headgasket, or rings.
50	List of Engine Failure Causes	Now, look at your list of possible causes of engine failure. If you are not able to pinpoint the reasons for the engine's poor operation, then you may have to start looking inside the engine parts.
51	Close-up of flywheel key in crankshaft	Begin by looking at the flywheel key. A sheared flywheel key can mean that the mower blade has hit something solid and it may be broken or that the magneto timing is off. This causes the engine to show a lack of power, misfire under a load, make a knocking sound, or shake.
52	Arrow pointing to contact points	While you have the flywheel off, check the contact points for burned spots, oil and dirt and correct gap setting. Make sure the contact points and condenser are securely tightened and that the contact point's cover is not cracked. Any of these problems will cause the engine to misfire under a load, lack power, or easily stop.
53	Arrow pointing to valves	To find the real cause of the engine trouble, you may even need to go further into the engine and inspect the valves for the correct clearance or, . . .
54	Arrow pointing to piston	check the piston and piston rings for wear, and . . .
55	Arrow pointing to combustion chamber	inspect the combustion chamber for carbon build-up.
56	6. Make a conclusion	When you think that you have completely inspected the engine and you have located the possible causes for the engine trouble, then it is time for you to decide what needs to be done to correct the problem. This is the sixth step in troubleshooting.
57	Finger pointing to a cause on the list	To make a conclusion, look over your list of possible causes, and pick out the one that you think is causing the engine trouble.

SLIDE NO.	SLIDE DESCRIPTION	NARRATIVE
37	Screwdriver turning carburetor adjustment screw	check the carburetor adjustment. Improper carburetor adjustment is a very common cause of an engine that won't start.
38	Arrow pointing to spark plug wire	Another major cause why an engine may not start and run is a faulty ignition system. First, check the spark plug wire to see if it is loose or cracked.
39	Spark tester checking spark plug for a spark	Then crank the engine and check to see if there is a spark at the spark tester when the engine is turned.
40	Fouled spark plug near spark plug hole	If there is a spark, then check the spark plug to see if it is fouled. If the spark plug is wet, then you will know that fuel is getting to the combustion chamber. If the spark plug is dry, then the engine problem is probably in the carburetor.
41	Hand writing "fouled spark plug" on List of Engine Failure Causes	If the spark plug is fouled, remember to write it down on your list of possible causes of engine failure instead of getting ahead of yourself and changing the spark plug. There may be some other engine problems that you might overlook.
42	Gap setter in gap to spark plug	If the spark plug is clean, check the gap setting and . . .
43	Arrow pointing to porcelain on spark plug	the porcelain to see if it is cracked.
44	Arrow pointing to throttle cable	Now, check the other wires and linkages, such as the throttle cable. Make sure the cable clamp is not rusty or bolted down so tightly that the throttle cable cannot move or that the clamp is so loose that it is not holding the cable properly.
45	Arrow pointing to governor linkage	Check the governor linkage to see if it is bent. A bent governor linkage could cause a lack of power or too much power in the engine.
46	Compression gauge connected to engine showing poor compression	Next, take a compression reading. Poor compression of less than 50 pounds will make the engine hard to start, and to lose power.
47	Torque wrench tightening cylinder head bolts	If there is low compression, or none at all, then check for a loose spark plug or cylinder head bolts, or a low cranking speed.

SLIDE NO.	SLIDE DESCRIPTION	NARRATIVE
58	7. Test the conclusion	The last step in troubleshooting is then to test your conclusion. To do this, study all the information that you have gathered about the engine, and if possible try it out before repairing the engine.
59	Close-up of Troubleshooting Chart	A Troubleshooting Chart that lists the common causes of engine failure and the solutions may be very helpful in testing your conclusion. Compare your conclusion with the information provided on a troubleshooting chart to see if they match.
60	Mechanic bent over lawnmower	By now, you probably can tell that sometimes it will be very easy to troubleshoot an engine, and sometimes it will be very hard; but the more practice you have in repairing enginas, the easier the job of troubleshooting will become for you.
61	7 Troubleshooting Steps 1. Know the engine 2. Find out the signs 3. Start the engine 4. Inspect the engine 5. List possible causes 6. Make a conclusion 7. Test the conclusion	Just remember, that following these seven basic troubleshooting steps on every engine that comes into the repair shop will make you a very valuable employee . . .
62	Customer shaking hands with mechanic	because good fast service means continued business with satisfied customers (music under) and less work that is returned.
63	(Credits)	(Music up and out)

STUDENT ACTIVITY SHEETS

STUDENT ACTIVITY 1

WHAT DOES TROUBLESHOOTING MEAN?
(TO BE USED WITH THE AUDIOVISUAL PRESENTATION)

A. DIRECTIONS: LOOK AT THE PRESENTATION SLIDES 1-18. TELL YOUR TEACHER OR WRITE DOWN THE ANSWERS TO THE FOLLOWING QUESTIONS.

1. WHAT IS ONE OF THE MOST VALUABLE SKILLS YOU CAN HAVE AS A SMALL ENGINE MECHANIC?

2. A STEP-BY-STEP PROCESS FOR FINDING THE CAUSE OR TROUBLE OF ENGINE FAILURE IS CALLED _____.

3. THE THREE THINGS THAT ARE NEEDED FOR ALL ENGINES TO RUN ARE _____, _____,

   AND _____.

4. THE MIXING OF FUEL AND AIR INTO A FINE MIST IN THE CARBURETOR IS CALLED _____.

5. SQUEEZING THE FUEL/AIR MIXTURE INTO A SMALL SPACE IN THE COMBUSTION CHAMBER SO THAT IT WILL CREATE POWER WHEN IT IS IGNITED IS CALLED _____.

6. AN EXPLOSION IN THE COMBUSTION CHAMBER CAUSED BY SETTING FIRE TO THE COMPRESSED AIR/FUEL MIXTURE IS CALLED _____.

7. WHEN A MECHANIC PUTS NEW PARTS IN AN ENGINE, HOPING TO CORRECT THE ENGINE FAILURE BEFORE UNDERSTANDING THE CAUSE OF ENGINE FAILURE IS CALLED _____ _____.

8. LIST 7 COMMON SIGNS OF ENGINE FAILURE.

   A. E.

   B. F.

   C. G.

   D.

B. DIRECTIONS: FILL IN THE BLANKS IN THE SENTENCES, USING THE WORDS BELOW. THEN FILL IN THE CROSSWORD PUZZLE.

POWER	TROUBLESHOOTING
SEVEN	CARBURETION
START	EXCHANGING
IGNITION	COMPRESSION

ACROSS

4. THE MIXING OF FUEL AND AIR INTO A FINE MIST IS CALLED _____.

6. WHEN THE FUEL/AIR MIXTURE IS SQUEEZED INTO A SMALL SPACE IN THE COMBUSTION CHAMBER, THIS IS CALLED _____.

DOWN

1. BEING ABLE TO FIND THE CAUSE OR TROUBLE OF ENGINE FAILURE IN A STEP-BY-STEP PROCESS IS CALLED _____.

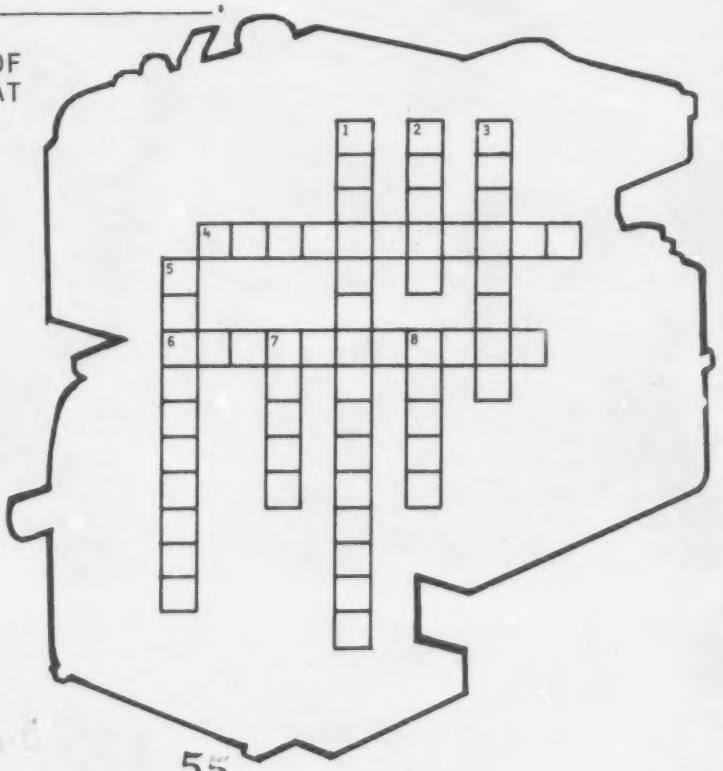
2. THERE ARE _____ STEPS TO TROUBLESHOOTING.

3. THE ACTION OF SETTING FIRE TO THE COMPRESSED FUEL/AIR MIXTURE AND CAUSING AN EXPLOSION IN THE COMBUSTION CHAMBER IS CALLED _____.

5. THE ALTERNATIVE TO TROUBLESHOOTING IS PARTS _____.

7. A COMMON SIGN OF ENGINE FAILURE IS THAT AN ENGINE WILL LACK _____.

8. ANOTHER COMMON SIGN OF ENGINE FAILURE IS THAT THE ENGINE WILL NOT _____.



STUDENT ACTIVITY 2

THE FIRST 5 STEPS TO TROUBLESHOOTING
(To be used with the audiovisual presentation)

A. Directions: Look at the presentation slides 15-24. Tell your teacher or write down the answers to the following questions.

1. What is the first thing that a good mechanic has done before a broken engine is ever touched?

2. The second step in troubleshooting an engine is to find out about the engine's performance by asking the customer questions. What four questions would YOU ask the customer about their broken engine?

   A.

   B.

   C.

   D.

3. What are the third and fourth steps in troubleshooting?

   A.

   B.

4. What is the fifth step in troubleshooting?

B. Directions: Check(✓) the following statemens that are <u>correct</u> about the first five steps in troubleshooting.

_____1. If you do not know how an engine operates, then go ahead and repair it.

_____2. The first step in troubleshooting is to know the engine.

_____3. A good mechanic reads all the latest service bulletins that are sent out by Briggs and Stratton and Tecumseh.

_____4. To find out about an engine's performance, replace the spark plug so you can start it.

_____5. Ask the customer what the engine is doing to find out about the engine's performance.

_____6. AN IMPORTANT QUESTION TO ASK THE CUSTOMER ABOUT THE ENGINE'S PERFORMANCE IS HOW IS THE ENGINE USED AND HOW OFTEN IT IS USED.

_____7. THE THIRD STEP IN TROUBLESHOOTING IS TO TELL THE CUSTOMER THAT THE ENGINE CAN'T BE FIXED AND TO BUY A NEW ONE.

_____8. THE FOURTH TROUBLESHOOTING STEP IS TO INSPECT THE ENGINE. THIS MEANS TO LOOK AT IT AND SEE IF IT NEEDS A NEW PAINT JOB.

_____9. LISTING THE POSSIBLE CAUSES OF ENGINE TROUBLE IS THE FIFTH TROUBLESHOOTING STEP.

STUDENT ACTIVITY 3

INSPECTING AN ENGINE WHEN TROUBLESHOOTING
(TO BE USED WITH THE AUDIOVISUAL PRESENTATION)

DIRECTIONS: LOOK AT THE PRESENTATION SLIDES 25-55. TELL YOUR TEACHER OR WRITE DOWN THE ANSWERS TO THE FOLLOWING QUESTIONS.

1. LIST FOUR THINGS THAT YOU SHOULD FIRST LOOK FOR WHEN INSPECTING AN ENGINE.

   A.

   B.

   C.

   D.

2. IF THE ENGINE WILL NOT START OR RUN PROPERLY, MOST LIKELY IN WHAT SYSTEM IS THE CAUSE OF THE ENGINE FAILURE?

3. WHEN CHECKING FOR A FAULTY FUEL SYSTEM, THERE ARE ABOUT 9 THINGS THAT COULD BE THE PROBLEM. NAME 5 THINGS THAT YOU WOULD CHECK THAT MIGHT BE THE PROBLEM OF A FAULTY FUEL SYSTEM.

   A.

   B.

   C.

   D.

   E.

4. ANOTHER MAJOR CAUSE FOR ENGINE FAILURE IS A FAULTY IGNITION SYSTEM. IF YOU THINK THE PROBLEM IS IN THE IGNITION SYSTEM, WHAT IS THE FIRST THING YOU WOULD CHECK?

5. AFTER YOU HAVE CHECKED THE SPARK PLUGS, WHAT ARE TWO MORE ENGINE PARTS THAT YOU COULD CHECK FOR A FAULTY IGNITION SYSTEM?

   A.

   B.

6. NAME 3 THINGS THAT MIGHT CAUSE A LOW COMPRESSION READING OR NO READING AT ALL.

   A.

   B.

   C.

7. WHAT COULD A SHEARED FLYWHEEL KEY MEAN?

8. NAME 4 THINGS FOUND INSIDE THE ENGINE THAT COULD CAUSE THE ENGINE TO MISFIRE UNDER A LOAD, LACK POWER, OR EASILY STOP.

   A.

   B.

   C.

   D.

STUDENT ACTIVITY 4

The Last 2 Steps to Troubleshooting
(To be used with the audiovisual presentation)

Directions: Look at the presentation slides 56-63. Tell your teacher or write down the answers to the following questions.

1. What is the sixth step in the troubleshooting procedure?

2. How do you make a conclusion in following a troubleshooting procedure?

3. What is the last step in troubleshooting?

4. A chart that lists the most common causes of engine failure and tells what to do to correct the problem is called a _____.

5. What do you need to do to make troubleshooting an engine easier?

STUDENT ACTIVITY 5

MATCH THE REMEDY WITH THE CAUSE OF ENGINE TROUBLE

DIRECTIONS: A VERY IMPORTANT TROUBLESHOOTING SKILL THAT A MECHANIC MUST HAVE IS TO BE ABLE TO KNOW WHAT TO DO WHEN THE CAUSE OF ENGINE TROUBLE IS FOUND. KNOWING WHAT TO DO TO CORRECT THE ENGINE TROUBLE IS CALLED A REMEDY. IN THIS ACTIVITY, MATCH THE CORRECT REMEDY WITH THE CAUSE OF ENGINE TROUBLE.

_____1. BURNED AND PITTED CONTACT POINTS	A. CLEAN WITH A THIN WIRE
_____2. SPARK PLUG GAP TOO WIDE	B. SERVICE REWIND SPRING
_____3. SHEARED FLYWHEEL KEY	C. REPLACE AND RESET GAP
_____4. WATER IN FUEL TANK	D. ALTERNATELY TIGHTEN TO CORRECT TORQUE
_____5. CLOGGED VENT HOLES IN FUEL TANK CAP	E. ADJUST GAP TO .015 - .025
_____6. CARBURETOR TIMING OFF	F. DRAIN FROM TANK AND CARBURETOR AND RE-PLACE WITH FRESH FUEL
_____7. DIRTY AIR CLEANER FILTER (OIL-FOAM TYPE)	G. REPLACE WITH NEW KEY
_____8. REWIND ROPE WILL NOT REWING INTO ENGINE	H. CLEAN WITH EMERY CLOTH AND RESET ARMATURE AIR GAP
_____9. LOOSE CYLINDER HEAD BOLTS	I. WASH IN SOAPY WATER, DRY, AND REOIL
_____10. RUSTY FLYWHEEL MAGNETS	J. ADJUST NEEDLE VALVES

STUDENT ACTIVITY 6

Troubleshoot an Engine

Directions: Your teacher will give you an engine that does not run or does not run properly. Use the following troubleshooting check-list to help you troubleshoot the cause of the engine failure.

Troubleshooting Step 1: KNOW THE ENGINE

Check "✓" if you know how to

_____ stop the engine

_____ start the engine

Is the engine a:

_____ 4-stroke-cycle engine

_____ 2-stroke-cycle engine

Troubleshooting Step 2: FIND OUT THE ENGINE SIGNS

Ask the customer or your teacher these questions, Check "✓" if the answer is yes.

1. Does the engine:

_____ Overheat _____ Vibrate _____ Misfire

_____ Run evenly _____ Knock _____ Start

2. How is the engine used? _____ Home use _____ Industrial use

_____ Other:

3. How often is it used? _____

4. How frequently is it serviced? _____

5. When was the last time it was serviced? _____

6. List other Engine Performance Signs:

Troubleshooting Step 3: START THE ENGINE

Check " " if the answer is yes.

1. Does the engine have:

_____ at least 1/2 tank of fresh fuel _____ full oil level

_____ correct mixture of fuel and oil for 2-stroke cycle engine _____ clean, fresh oil

2. _____ Does the engine start? (If the answer is "No", go to Step 4)

3. _____ Is the engine hard to start?

4. _____ If the engine starts, does it run evenly?

5. _____ While engine is running, are there any oil leaks?

6. _____ While engine is running, are there any unusual sounds?

Troubleshooting Step 4: INSPECT THE ENGINE

If the engine will NOT start, check for:

1. _____ Ignition troubles - weak spark at plug
2. _____ Ignition troubles - no spark at plug
3. _____ Low compression
4. _____ Fuel Problems - plug wetted out
5. _____ Fuel Problems - no fuel in carb
6. _____ Fuel Problems - spark plug dry

If the engine starts but runs poorly, check for:

1. _____ Engine lacks power (incorrect timing)
2. _____ Engine vibrates
3. _____ Engine smokes excessively - high oil consumption
4. _____ Engine smokes excessively - overheating

Troubleshooting Step 5: LIST POSSIBLE CAUSES OF ENGINE TROUBLE

Troubleshooting STEP 6: MAKE A CONCLUSION

What is the cause of engine trouble?_____

_____

Troubleshooting Step 7: TEST YOUR CONCLUSION

Tryout your conclusion on the engine.

1. Did you make the right conclusion of the engine trouble?

2. Does the engine run correctly now?

ANSWERS TO STUDENT ACTIVITIES

NOTE: Responses to the short answer questions may vary according to the student's level of understanding, experience, and ability to express oneself. The following answers are provided as examples of the kind of information that a student could give.

Student Activity 1: What Does Troubleshooting Mean?

A. 1. To be able to quickly and accurately find the cause of engine failure or to be able to troubleshoot an engine

2. Troubleshooting

3. carburetion, compression, ignition

4. carburetion

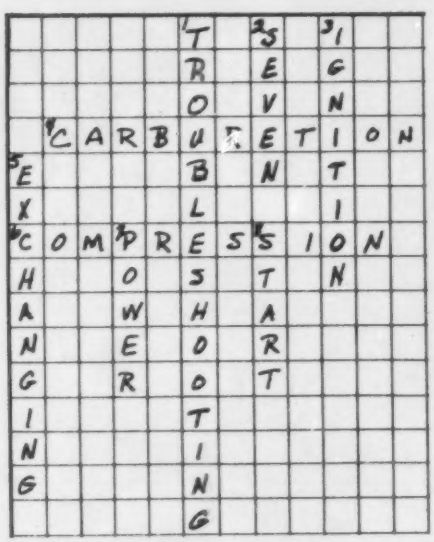
5. compression

6. ignition

7. parts exchanging

8. a. will not start
   b. knocks
   c. misfires
   d. lacks power
   e. overheats
   f. surges or runs unevenly
   g. shakes

B.



Student Activity 2: The First 5 Steps to Troubleshooting

A. 1. Studied the service manuals of engines and keeps up with the latest service bulletins or knows how the engine is designed and how it operates.

2. a. Ask the customer what is happening in the engine that is not supposed to happen, for example, does the engine knock, misfire, overheat, or vibrate.

b. Ask the customer what is <u>not</u> happening in the engine that is supposed to happen, for example, does the engine start, or run evenly.

c. Ask the customer how it is used, and how often it is used.

d. Ask the customer how frequently it is cleaned and serviced.

3. a. Start the engine, if possible.

b. Inspect the engine while it is running.

4. List all the possible causes of engine trouble

B.

_____1.	___✓___6.
___✓___2.	_____7.
___✓___3.	_____8.
_____4.	___✓___9.
___✓___5.	

Student Activity 3: Inspecting an Engine When Troubleshooting

1. a. low fuel and oil levels or dirty oil

b. Faulty fuel system or clogged fuel strainer

c. restrictions in the air intake passages, or a clogged breather

d. connections of all hoses, manifold, and wires like the spark plug wire to be sure they are secure and tight

2. fuel system

3. a. check to see that there is at least ½ tank of fuel

b. check the fuel shut-off valve to see that it is open

c. check the fuel tank for water

d. check the fuel filters and fuel lines to see if they are clogged or pinched

e. check the air intake for the fuel system, or holes in vent cap to see if they are clogged

Other answers: check the engine cooling fins for dirt and grass; check the air cleaner filter for clogging; check for a stuck choke valve, check the carburetor adjustment

4. check the spark plug wire to see if it is loose or cracked

5. a. other wires and linkages such as the throttle cable
   b. governor linkage

6. a. loose spark plug, cylinder head bolts, or low cranking speed
   b. dry piston rings
   c. stuck on bad valve, headgasket, rings

7. A sheared flywheel key can mean that the mower blade hit something solid and it may be broken or that the magneto timing is off.

8. a. Contact points with burned spots, oil, and dirt
   b. Incorrect gap setting on contact points
   c. Loose contact points or condenser
   d. Cracked contact point cover

Student Activity 4: The Last 2 Steps to Troubleshooting

1. The sixth step in Troubleshooting is to make a conclusion or decide what needs to be done to correct the problem.

2. Look over your list of possible causes, and pick out the one that you think is causing the engine trouble.

3. The last step in troubleshooting is to test your conclusion.

4. Troubleshooting Chart

5. A lot of practice repairing engines.

Student Activity 5: Match the Remedy with the Cause of Engine Trouble

1. c	5. a	8. b
2. e	6. j	9. d
3. g	7. i	10. h
4. f		

Student Activity 6: Troubleshoot an Engine

NOTE: The evaluation of this activity is at the discretion of the instructor. Generally, the student should be able to follow the seven troubleshooting steps when troubleshooting an engine.

EVALUATION MODEL

The chart on the following page is to be used by the teacher as a motivational aid and by the student as a self-evaluation of individual progress toward learning information about troubleshooting and performing the seven troubleshooting steps on engines.

The evaluation of each student's troubleshooting knowledge and performance should begin after the student completely understands what is expected and some demonstrated progress toward the objectives is evident. Because the learning rate in some special needs students varies greatly, the evaluation period will also vary among students. However, it is recommended that evaluation should last for a minimum period of two weeks or 10 consecutive school days. This length of time will allow most students to overlearn the troubleshooting objectives and thus achieve competency.

The rating scale for the following evaluation chart is divided into 3 steps.

RATING	MEANING
1 =	Does not reach the objective
2 =	Reaches the objective, but needs help or needs to be reminded.
3 =	Reaches the objective without help. Ready for job entry with shop supervision.

Criterion for competency or the rating that a student must achieve for a predetermined length of time is suggested to be a rating of 3 on the evaluation chart for three consecutive days. For example, whan a student is able to demonstrate knowledge about troubleshooting or perform the seven troubleshooting steps without help for three consecutive days, then the student has reached criterion and is considered competent in that area.

STUDENT'S NAME_____

TROUBLESHOOTING Evaluation Chart	DAYS									
	1	2	3	4	5	6	7	8	9	10
THINGS TO KNOW										
1. Tells the definition of troubleshooting										
2. Names 3 engine operations necessary for the engine to run										
3. Names 7 common signs of engine failure										
4. Names 7 troubleshooting steps										
THINGS TO DO										
Follows the 7 troubleshooting steps 1. Knows the engine										
2. Finds out the engine signs										
3. Starts the engine										
4. Inspects the engine										
5. Lists possible causes of trouble										
6. Makes a conclusion										
7. Tests the conclusion										
SAFETY Follows all safety rules when troubleshooting										

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SMALL ENGINE TROUBLESHOOTING CHART

ENGINE WILL NOT START

LOW COMPRESSION

- valve stuck open
- carbon on valve seat
- loose spark plug
- worn bore or rings
- defective piston
- burned valves
- incorrect valve clearance
- defective reed valve
- loose head bolts
- blown head gasket
- piston rings stuck
- broken connecting rod

FUEL PROBLEMS

PLUG WETTED OUT

- choke stuck or over-used
- stale fuel
- float stuck open
- mixture too rich
- defective spark plug
- water in fuel
- excessive oil in two-stroke mixture
- air cleaner dirty or saturated with fuel

NO FUEL IN CARB

- fuel tank empty
- fuel valve shut off
- carb float valve stuck or clogged
- blocked fuel filter
- blocked fuel line
- fuel tank vent plugged

SPARK PLUG DRY

- choke not closing
- intake manifold leak
- diaphragm-type carb not pumping fuel
- jets dirty
- crankcase leaking on two-stroke type

IGNITION TROUBLES

NO SPARK AT PLUG

- kill button or wires grounded out
- points corroded
- condenser shorted
- high-voltage wire shorted or open
- defective magneto armature (coil)
- point plunger stuck

WEAK SPARK AT PLUG

- point gap incorrect
- magneto air gap too wide
- defective condenser
- defective magneto armature (coil)
- defective lighting circuit

ENGINE STARTS BUT RUNS POORLY

LACKS POWER

- timing incorrect
- point gap incorrect
- clogged muffler or exhaust port
- carb out of adjustment
- low compression
- not getting full throttle
- governor defective
- dirty air cleaner

ENGINE VIBRATES

- bent crankshaft
- blower out of balance
- worn drive couplings
- attachments such as mower blades out of balance

ENGINE SMOKES EXCESSIVELY

HIGH OIL CONSUMPTION

- loose flywheel
- wrong oil used
- oil diluted from rich mixture
- engine overheating
- worn rings or bore
- burned piston
- clogged crankcase breather
- wrong fuel/oil mix on two-cycle type

OVERHEATING ENGINE

- cooling fins blocked
- engine overloaded
- ignition timing late
- dirty cooling blower
- clogged muffler
- governor out of adjustment allowing over-speed
- piston or rings fitted too tight